What we claim and desire to protect by Letters Patent is:

1. An optoelectronic system suitable for coupling optical communication means between a first side of a substrate to a second side of a substrate by means of a vertical guide optical via comprising:

a substrate having a top surface and a bottom surface,

a through via extending vertically from said top surface to said bottom surface,

said through via having sidewalls covered with a layer of low refractive index material,

said via with said low refractive index material on said sidewalls being substantially or fully filled with a high refractive index material to form a core layer;

said refractive indices of said materials being either low or high relative to each other;

light emitting and receiving elements aligned to said vertical guide optical via.

2. The optoelectronic system defined in Claim 1 wherein said substrate is selected from the group consisting of silicon, germanium, indium phosphide, silicon/germanium, gallium arsenide, glass, quartz, sapphire and silicon carbide.

3. The optoelectronic system defined in Claim 2 wherein said layer of low refractive index is a cladding layer formed from silicon dioxide or a polymer selected from the group consisting of acrylate polymers, siloxane polymers and vapor deposited polymer layers.

4. The optoelectronic system defined in Claim 2 wherein said high refractive index material forming said core layer is formed from silicon dioxide or a polymer selected from the group consisting of acrylate polymers, siloxane polymers and vapor deposited polymer layers.

5. The optoelectronic system defined in Claim 2 wherein said layer of low refractive index is a cladding layer formed from silicon dioxide or a polymer selected from the group consisting of acrylate polymers, siloxane polymers and vapor deposited polymer layers and wherein said high refractive index material forming said core layer is formed from silicon dioxide or a polymer selected from the group consisting of acrylate polymers, siloxane polymers and vapor deposited polymer layers.

6. The optoelectronic system defined in Claim 1 wherein said light signal source elements are selected from the group consisting of light emitting carbon nanotube, vertical cavity surface emitting laser (VCSEL), light emitting diode (LED), edge emitting laser, external source, wave guiding element, optical fiber means.

7. The optoelectronic system defined in Claim 1 wherein said light receiving elements are selected from the group consisting of a photodetector, optical fiber, or waveguide.

8. The optoelectronic system defined in Claim 6 wherein said light signal source is a vertical cavity surface emitting laser (VCSEL).

9. The optoelectronic system defined in Claim 7 wherein said light recieveing element is a photodetector.

10. The optoelectronic system defined in Claim 2 wherein said vertical optical channel guide via has a center post constructed from a high refractive index material surrounded by an annulus forming an annular via having a volume of desired dimension.

11. An optoelectronic system suitable for coupling optical communication means between a first side of a substrate to a second side of a substrate by means of a vertical guide optical via comprising:

a substrate having a top surface and a bottom surface,

a via extending vertically from said top surface substantially to said bottom surface,

said vertical optical channel guide via having a center post, constructed out of the material forming said substrate, surrounded by an annulus forming an annular via having a volume of desired dimension, a bottom of said via extending radially outward from said center post to intersect said sidewalls;

said via is covered with a layer of low refractive index material

said via with said low refractive index material on said sidewalls being substantially or fully filled with a material.

12. The optoelectronic system defined in Claim 11 wherein said substrate is selected from the group consisting of silicon, germanium, indium phosphide, silicon/germanium, gallium arsenide, glass, quartz, sapphire and silicon carbide.

13. The optoelectronic system defined in Claim 12 wherein said centerpost is capable of transmitting optical signals.

14. The optoelectronic system defined in Claim 12 wherein said centerpost is incapable of transmitting optical signals.

15. The optoelectronic system defined in Claim 13 wherein said centerpost is coated with a low refractive index material.

16. The optoelectronic system defined in Claim 13 wherein said sidewalls and a portion of said top of said substrate abutting said sidewalls is coated with an electrically conductive material.

17. The optoelectronic system defined in Claim 13 wherein an electrically conductive connection means extends from said bottom surface of said substrate through said substrate to said electrically conductive material covering said sidewalls.

18. The optoelectronic system defined in Claim 13 wherein an electrically conductive connection means extends from said bottom surface of said substrate through said substrate to said electrically conductive material covering said sidewalls, and wherein said sidewalls and a portion of said top of said substrate abutting said sidewalls is coated with an electrically conductive material.

19. The optoelectronic system defined in Claim 18 wherein said layer covering said sidewalls and center post is a cladding layer formed from silicon dioxide or a polymer selected from the group consisting of acrylate polymers, siloxane polymers and vapor deposited polymer layers.

20. The optoelectronic system defined in Claim 13 wherein said volume of said annular via is fully or partially filled with a material selected from the group consisting of an optical, electrical or dielectric filler material.

21. The optoelectronic system defined in Claim 20 wherein said optical material filling said volume is an optically transparent polymer.

22. The optoelectronic system defined in Claim 22 wherein said optically transparent polymer is selected from the group consisting of acrylates and siloxanes.

23. The optoelectronic system defined in Claim 20 wherein said electrical material filling said volume is conductive copper paste.

24. The optoelectronic system defined in Claim 20 wherein said dielectric filler material is a dielectric polymer.

25. The optoelectronic system defined in Claim 24 wherein said dielectric polymer is selected from the group consisting of epoxy or polyimide.

26. The optoelectronic system defined in Claim 20 wherein said dielectric filler material is selected from the group consisting of inorganic dielectrics spun on glass.

27. The optoelectronic system defined in Claim 13 wherein said light signal source elements are selected from the group consisting of light emitting carbon nanotube, vertical cavity surface emitting laser (VCSEL), light emitting diode (LED), edge emitting laser, external source, wave guiding element, optical fiber means.

28. The optoelectronic system defined in Claim 13 wherein said light receiving elements are selected from the group consisting of a photodetector, optical fiber, or waveguide.

29. The optoelectronic system defined in Claim 27 wherein said light emitting element is a vertical cavity surface emitting laser (VCSEL).

30. The optoelectronic system defined in Claim 28 wherein said light receiving element is a photodetector.

31. The optoelectronic system defined in Claim 18 wherein said electrically conductive connection means is any material suitable for forming an electrical connection.

32. The optoelectronic system defined in Claim 18 wherein said electrically conductive connection means is selected from the group consisting of solder and a conductive adhesive.

33. The optoelectronic system defined in Claim 31 wherein said electrically conductive connection means is connected to a foreign substrate with complimentary electrically conductive signal lines.

34. The optoelectronic system defined in Claim 33 wherein said foreign substrate is selected from the group consisting of a circuit board, a silicon substrate and a ceramic substrate.

35. An optoelectronic system suitable for coupling optical communication means between a first side of a substrate to a second side of a substrate by means of a vertical guide optical via comprising:

a substrate having a top surface and a bottom surface,

a through via extending vertically from said top surface to said bottom surface of said substrate,

said via being fully filled with a transparent material having a top surface and a bottom surface, said bottom of said transparent material configured to form optical light directing elements,

light emitting and receiving elements aligned to said vertical guide optical via.

36. The optoelectronic system defined in Claim 35 wherein said substrate is selected from the group consisting of silicon, germanium, indium phosphide, silicon/germanium, gallium arsenide, glass, quartz, sapphire and silicon carbide.

37. The optoelectronic system defined in Claim 36 wherein said transparent material has low optical attenuation.

38. The optoelectronic system defined in Claim 37 wherein said material having low optical attenuation is a polymer selected from the group consisting of acrylate or siloxane polymers.

39. The optoelectronic system defined in Claim 36 wherein said optical directing elements are selected from the group consisting of refractive or diffractive means.

40. The optoelectronic system defined in Claim 39 wherein said optical directing means are refractive means.

41. The optoelectronic system defined in Claim 40 wherein said refractive means is a lens

42. The optoelectronic system defined in Claim 39 wherein said optical directing means are diffractive means.

43. The optoelectronic system defined in Claim 41 wherein said diffractive means is a grating.

44. The optoelectronic system defined in Claim 36 wherein said via is partially filled with a transparent material having a top surface and a bottom surface, and
said bottom of said transparent material configured to form a lens with a curved surface.

45. An optoelectronic system suitable for coupling optical communication means between a first side of a substrate to a second side of a substrate by means of a vertical guide optical via comprising:

a substrate having a top surface and a bottom surface;

a via partially extending vertically from said top surface toward said bottom surface;
said via having a center post surrounded by an annulus forming an annular via having sidewalls and a base defining a volume of desired dimension;

a plurality of layers extending radially outward from said center post, comprising an annular first layer which contacts said center post, and successive layers, each said layer possesses a refractive index higher than the contiguous layer preceding it up to a maximum refractive index value for a layer, and a number of layers of decreasing refractive indices, the resultant gradient refractive index values of the layers up to the maximum refractive index being suitable to guide light signal between top and bottom surfaces of the substrate;

light emitting and receiving elements aligned to said vertical guide optical via.

46. The optoelectronic system defined in Claim 45 wherein said layers have an index in the range of 1.45 to 2.0.

47. The optoelectronic system defined in Claim 46 wherein said layers are selected from the group consisting of silicon dioxide, silicon oxynitride, polyimide, vapor deposited polymers and polysiloxane.

48. The optoelectronic system defined in Claim 47 wherein said center post is a silicon pillar coated with silicon dioxide as the first layer thereon to optically isolate light transmitted in said layers from said pillar.

49. The optoelectronic system defined in Claim 45 wherein the diameter of said silicon pillar is less than the diameter of light beam guided through said center.

50. An optoelectronic system suitable for coupling optical communication means between a first side of a substrate to a second side of a substrate by means of a vertical guide optical via comprising:

a substrate having a top surface and a bottom surface;

a through via extending vertically from said top surface to said bottom surface;

a microlens array in alignment with said via;

light emitting and receiving elements aligned to said vertical guide optical via.

51. The optoelectronic system defined in Claim 50 wherein said microlens is situated within said via in said substrate.

52. The optoelectronic system defined in Claim 50 wherein said microlens is situated partially within said via in said substrate.

53. The optoelectronic system defined in Claim 50 wherein said microlens is situated outside said via in said substrate.

54. A method of forming an optoelectronic system suitable for coupling optical communication means between a first side of a substrate to a second side of a substrate by means of a vertical guide optical via comprising:

forming a via having sidewalls through a semiconductor substrate;

coating said sidewall with a low refractive index material;

partially or completely filling said via with a high refractive index material, said refractive indices of said materials being either low or high relative to each other;

fabricating wiring levels and attaching devices onto said semiconductor substrate.

55. The method of forming an optoelectronic system suitable for coupling optical communication means defined in Claim 54, said high refractive index material which partially or completely fills said via is the same or different material with varying refractive indices;

forming a microlens in said via by placing material with the highest refractive index and gradually decreasing said refractive index radially outward from the center of said via.

56. A method of forming an optoelectronic system suitable for coupling optical communication means between a first side of a substrate to a second side of a substrate by means of a vertical guide optical via comprising:

forming a blind or through annular via having sidewalls through a semiconductor substrate and forming a core made from the same material as said substrate;

coating said sidewall of either said via with a low refractive index material;

partially or completely filling a volume of said via with an optical, electrical or dielectric material;

fabricating wiring levels and attaching devices on said semiconductor substrate having said vertical channel guide optical via.

57. A method of forming an optoelectronic system suitable for coupling optical communication means between a first side of a substrate to a second side of a substrate by means of a vertical guide optical via comprising:

forming a blind or through annular via having sidewalls through a semiconductor substrate and forming a core made from the same material as said substrate;

partially covering said sidewall of said annular via with a low refractive index material and with electrically conductive material;

partially or completely filling any remaining volume of said electro-optical annular via with suitable optical, electrical or dielectric material;

forming an electrical connection to the bottom of said electro-optical via;

fabricating wiring levels and attaching devices on semiconductor substrate having said electro-optical via.

58. A method of forming an optoelectronic system suitable for coupling optical communication means between a first side of a substrate to a second side of a substrate by means of a vertical guide optical via comprising:

forming a partial or complete via having sidewalls through a semiconductor substrate;

filling said via with transparent material;

fabricating optical directing structures, either refractive or diffractive, at the bottom surface of said via.

59. A method of forming an optoelectronic system suitable for coupling optical communication means between a first side of a substrate to a second side of a substrate

by means of a vertical guide optical via with a lens structures at the bottom of said via, comprising:

forming a via having sidewalls through a semiconductor substrate;

filling said via with transparent material;

fabricating lens structures at the base of the via;

opening a back side of said via to expose said lensed via.

60. A method of forming an optoelectronic system suitable for coupling optical communication means between a first side of a substrate to a second side of a substrate by means of a vertical guide optical via, said vertical guide optical via having a discrete index gradient guiding pillar, comprising:

comprising:

forming a via having sidewalls through a semiconductor substrate;

said semiconductor substrate having one or plurality of partially etched thru annular vias;

depositing sequentially layers, each said layer having a decreasing refractive index ;

planarizing the top layer of said layers;

61. A method of forming an optoelectronic system suitable for coupling optical communication means between a first side of a substrate to a second side of a substrate by means of a vertical guide optical via, said optical via having a discrete index gradient support pillar, comprising:

forming a via having sidewalls through a semiconductor substrate, said semiconductor substrate having one or plurality of partially etched thru annular via;

depositing sequentially layers with a controlled refractive index resulting in a desired radial index profile;

planarizing a top layer of said layers;

planarizing a bottom layer of said layers.

62. A method of forming an optoelectronic system suitable for coupling optical communication means between a first side of a substrate to a second side of a substrate by means of a vertical guide optical via comprising:

forming a lens structure on one or both sides of a die in said via to collimate and or focus light from one side of the die to the other.